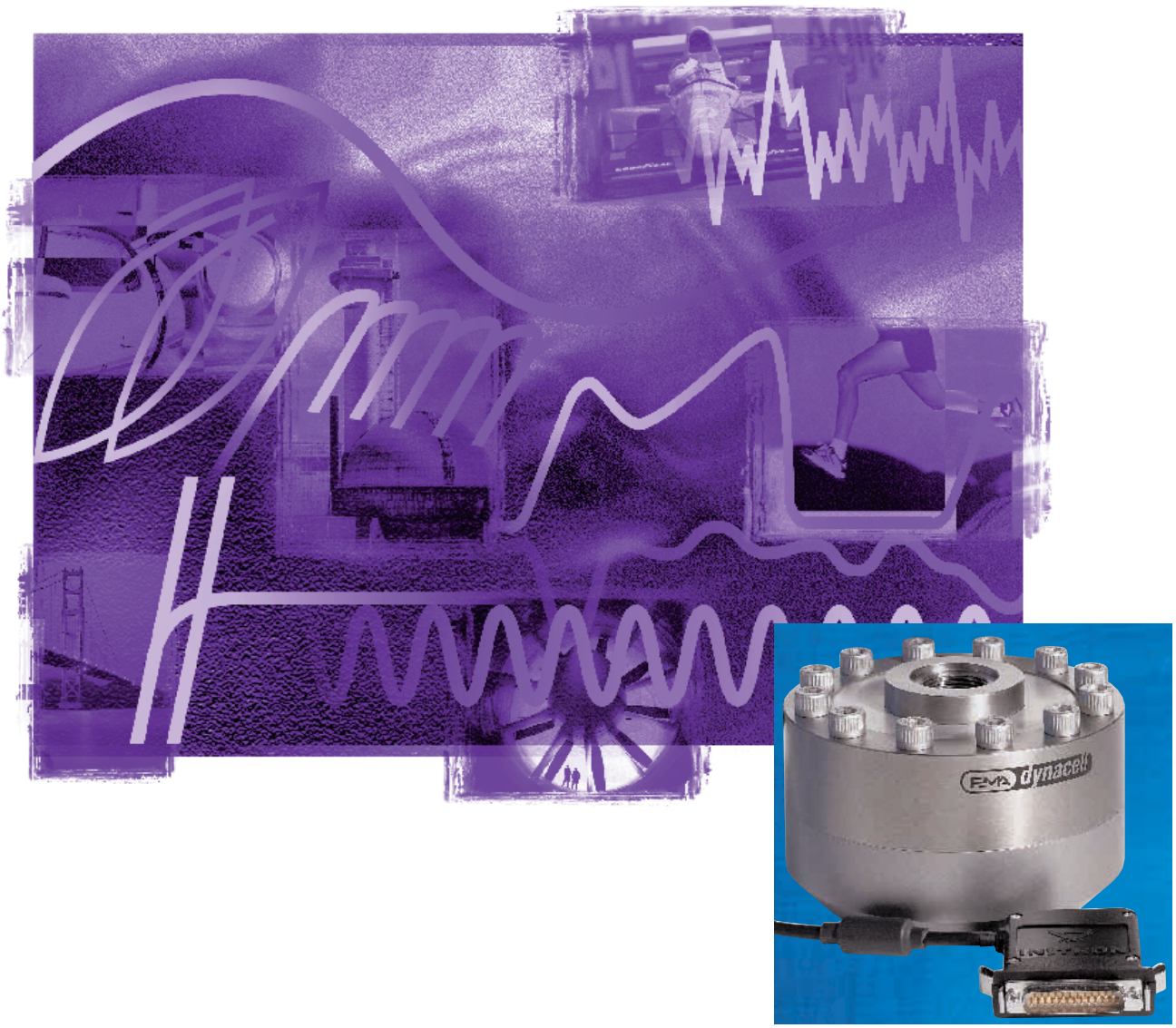
FAST TRACK 8800™

Dynacell™

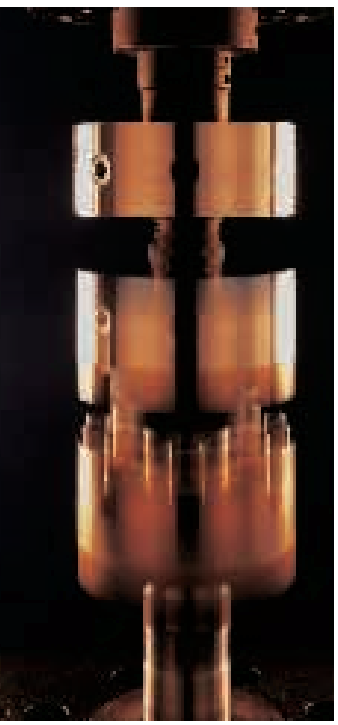
Bringing a dynamic dimension to force measurement



INSTRON

The difference is measurable

FEMA dynacell™



Dynacell - bringing a dynamic dimension to force measurement

During tests carried out on servohydraulic machines, elements of the system are subject to acceleration. As a result, in addition to the force applied to the specimen, the load cell also reads forces resulting from its own movement and the mass of the grips and fixtures attached to it.

The ASTM E4-96 standard states, "**CAUTION:** Practice E4 verification values are not assumed to be valid for high-speed or dynamic testing applications (see Practice E467)". Most fatigue rated load cells are actually designed for static load measurement, and are calibrated statically to ISO or ASTM standards. Dynacell is the world's first truly dynamic load cell, designed from the outset for measuring dynamic loads.

Dynacell introduces the following advantages:

- Reduces dynamic load errors which can be a significant percentage of reading
- Increases productivity by allowing higher frequency operation while maintaining test validity - improvements such as doubling the frequency are common
- Provides an improved closed loop load control for higher frequency testing
- Allows automatic set-up (when used with Instron FastTrack 8800 electronics), therefore reducing operator errors and improving system integrity

Figure 1 shows the difference between the load applied to the specimen and that read by the measuring device, such that

$$F_{cell} = F_{specimen} + ma$$

Where :

F_{cell} - is the force seen at the load cell

$F_{specimen}$ - is the force seen at the specimen

m - is the mass of the grip or fixture

a - is the acceleration of the grip or fixture

Consequently :

$$\mathbf{F_{cell} \neq F_{specimen}}$$

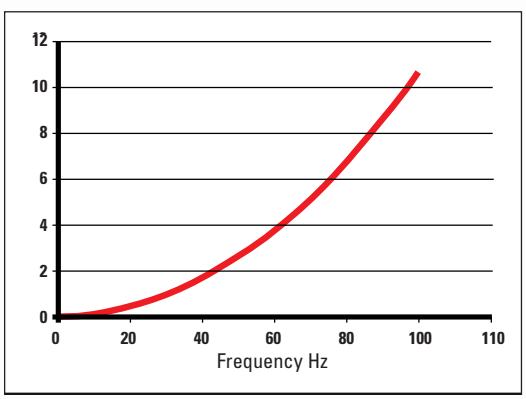


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Figure 2

Forces experienced by 100kN (22kip) load cell with 100kN (22kip) grips subject to an amplitude of 1mm (0.04in).

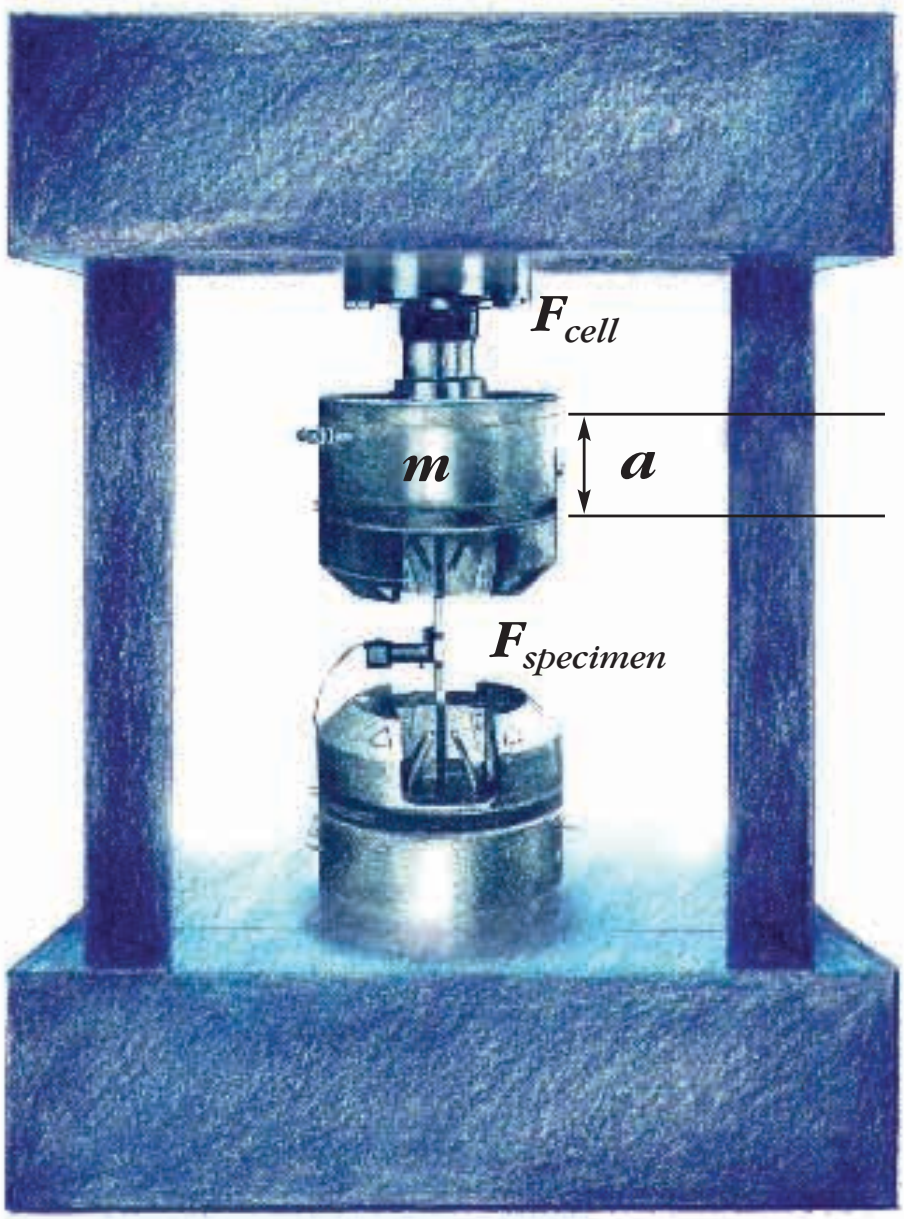


Figure 1
Relationship between the force measured at the load cell and that experienced at the specimen.

The scale of the error caused depends on the specific configuration of grips and fixtures, as well as the dynamic displacement of the load cell and the square of the frequency. Figure 2 shows an example of this, where the load cell is mounted at the end of a 100kN (22kip) actuator with a typical set of 100kN (22kip) hydraulic grips. While the most dramatic example of this error is highlighted by such a configuration, the error also arises when the actuator is in the base of the machine and the load cell is mounted on the crosshead, as shown in Figure 3. Round robin tests by ASTM suggest that many systems give errors in excess of 1% at frequencies above 20Hz.

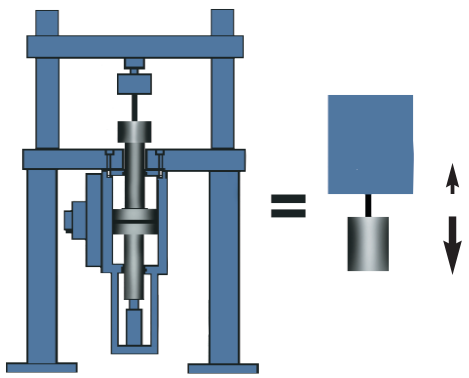
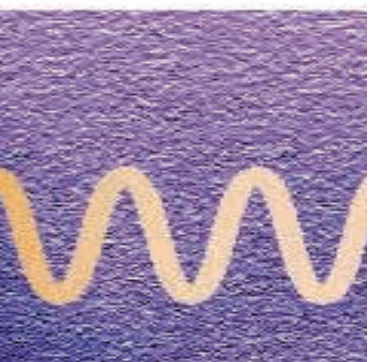


Figure 3
The effect of having the actuator mounted in the base and the load cell on the crosshead.



A smarter load cell for dynamic applications

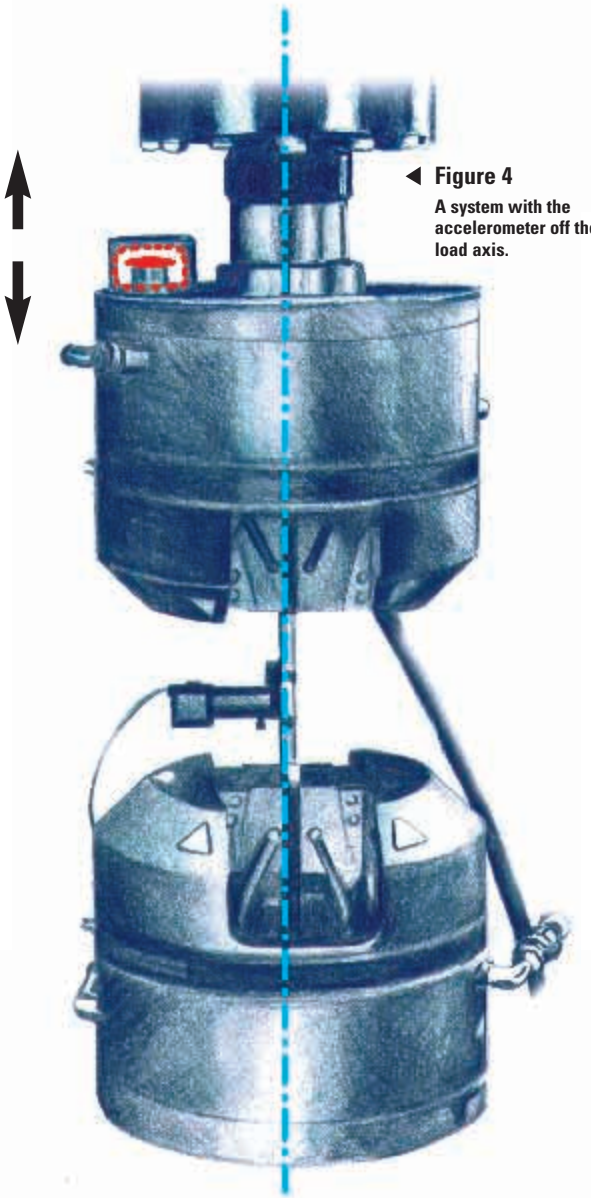


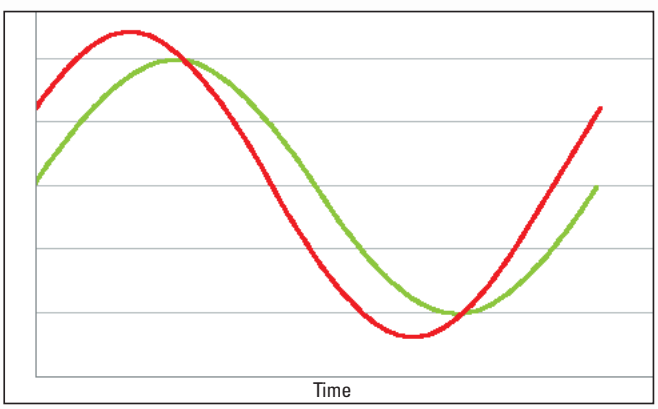
Figure 4
A system with the accelerometer off the load axis.

The old solution

To counteract this problem one approach adopted has been to place an accelerometer as close as possible to the load axis, condition the accelerometer signal with special electronics, and then adjust the load signal accordingly. This has several disadvantages:

- Errors result from the accelerometer being off the load axis. This is due to both amplitude and phase differences between that seen by the specimen and that seen by the accelerometer. An example of this is shown in Figure 4
- Manual set-up is time consuming, particularly when grips and fixtures are changed
- Manual set-up is prone to operator error

Figure 6
Comparison of the amplitude and phase differences between the Dynacell with the accelerometer on the load axis and another system with the accelerometer off the load axis.



Instron's Dynacell solution

With the Dynacell solution the error is minimized. You will see in Figure 5, that the accelerometer in a Dynacell is right at the heart of the load cell, directly on the load axis. This removes the risk of errors in the acceleration reading resulting from off center loading. In comparison to the old solution, this has the following advantages:

- The accelerometer is on the load line eliminating both amplitude and phase errors (a comparison is shown in Figure 6)
- Automatic set-up takes less than one minute
- Set-up is consistent and reliable between operators

The conditioning of the acceleration signal from the Dynacell is handled as standard in the FastTrack 8800 electronics, and is set-up automatically when the system is autotuned. This means that time is saved and operator errors reduced. For users who wish to do this themselves, they have the option to switch this feature on or off and set the correction factor manually.

The resulting signal is then subtracted from the load cell signal. That is:

$$F_{cell} = F_{specimen} + ma - ka_c$$

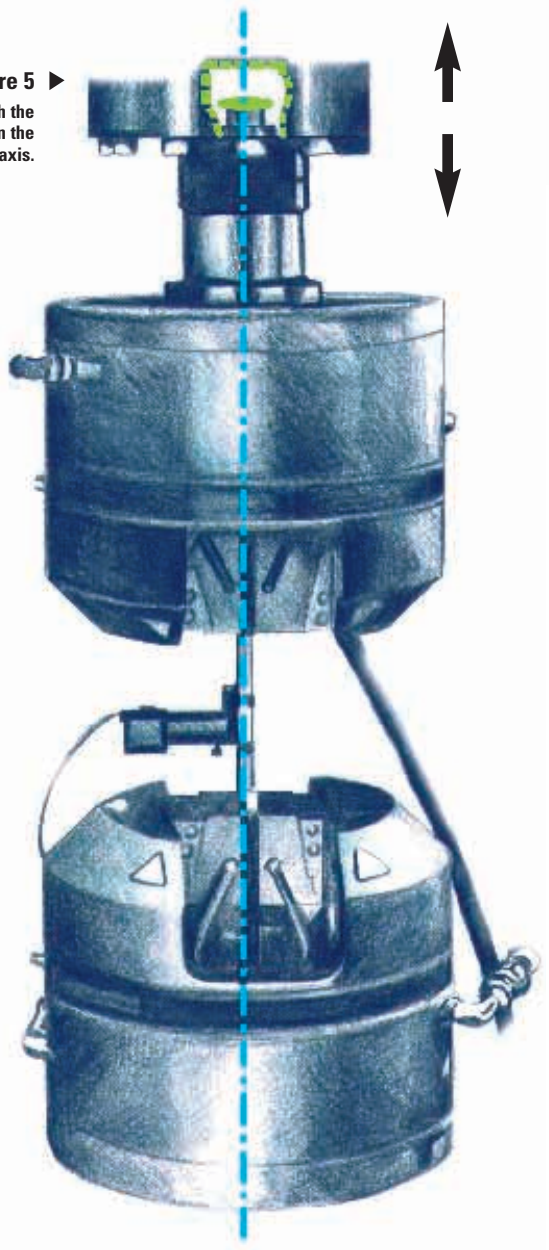
Where :

k - is the correction factor
a_c - is the signal from the accelerometer.

The result is that :

$$\mathbf{F_{cell} = F_{specimen}}$$

Figure 5 ▶
The Dynacell with the accelerometer on the load axis.



Specifications

Linearity (for static applications).....Better than ±0.25% of reading from 1% to 100% of load cell rating

Linearity (for dynamic applications) ....Error due to inertia force of attached mass reduced by at least 85% over 0 to 200Hz or, worst case, to a value of 0.5% of load cell rating, whichever is greater

Repeatability.....Better than ±0.25% of reading from 1% to 100% of load cell rating

Hysteresis.....Less than ±0.1% of full scale

Creep .....Less than ±0.1% of reading over 3 minutes minus 5 seconds at 20ºC

Zero error (residual indicated force) .....Less than ±0.5% of load cell rating after removing a series of forces

Load reversal zero shift .....Less than ±0.5% of load cell rating (tension to compression)

Sensitivity .....1.6 to 2.4mV/V

Zero balance .....Better than 2% of load cell rating

Bridge resistance .....700 ohms -5%, +15%

Insulation resistance .....Greater than 5000 Mohms at 50V dc

Excitation.....5V RMS at 5kHz

Deflection.....0.02mm at full load

Compensated temperature range.....0 to +50ºC

Storage temperature range.....-20 to +60ºC

Temperature effect on zero ..Less than ±0.002% of load cell rating per ºC

Temperature effect on sensitivity .....Less than ±0.002% of load cell rating per ºC

Resistance to thermal gradients .....Better than ±0.002% of load cell rating per ºC temperature difference across the load cell, lateral or axial

Zero stability .....Better than ±0.001% of load cell rating per hour. After short term stability achieved (isothermal test conditions)

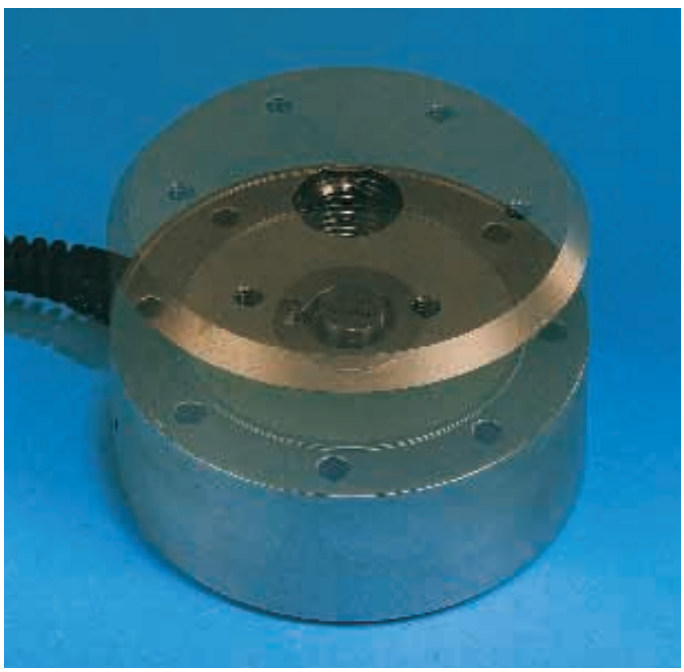
Offset loading .....Error due to offset static loading per 10mm radial offset less than ±0.5% of reading

All Instron 2527 Series Dynacell dynamic load cells, when used with FastTrack 8800 Series, will meet the requirements of ISO 75001/1 Class 0.5, ASTM E4, EN10002 Part 2, JIS (B7721, B7733) and ISO 10002 Part 2.

	2527-100	2527-101	2527-102	2527-103	2527-111	2527-113	2527-120	2527-125	2527-140
Construction	Shear cell	Shear cell	Shear cell	Shear cell	Shear cell	Shear cell	Sandwich	Sandwich	Sandwich
Capacity kN	50	25	10	5	100	250	1000	500	2500
Kip	11	5	2	1	22	55	220	110	550
Interface central thread	M30 X 2	M20 X 1.5	M20 X 1.5	M20 X 1.5	M30 X 2	M48 X 2	M100 X 4	M72 X 3	M150 X 4
Interface bolt patterns	NA	NA	NA	NA	NA	NA	12 X M30 on 225 PCD and 6 X M20 on 150 PCD	6 X M30 on 225 PCD and 6 X M20 on 150 PCD	NA
Side load resistance	40%	40%	40%	40%	40%	40%	200%	200%	200%

All Dynacells have an overload capability of 300% of capacity before mechanical failure
All Dynacells have a fatigue life in excess of 10^9 full stress reversed cycles

As you might expect from Instron, Dynacell is also a highly accurate static load cell, with a measurement accuracy better than 0.25% of reading down to 1% of the load cell full scale. When used with FastTrack 8800, an accuracy of better than 0.5% of reading down to 1% of the load cell full scale is easily achieved.



Inside of the Dynacell showing the integral accelerometer.

For information on Instron products and services,
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